Classification of Abnormal Driving Behaviors

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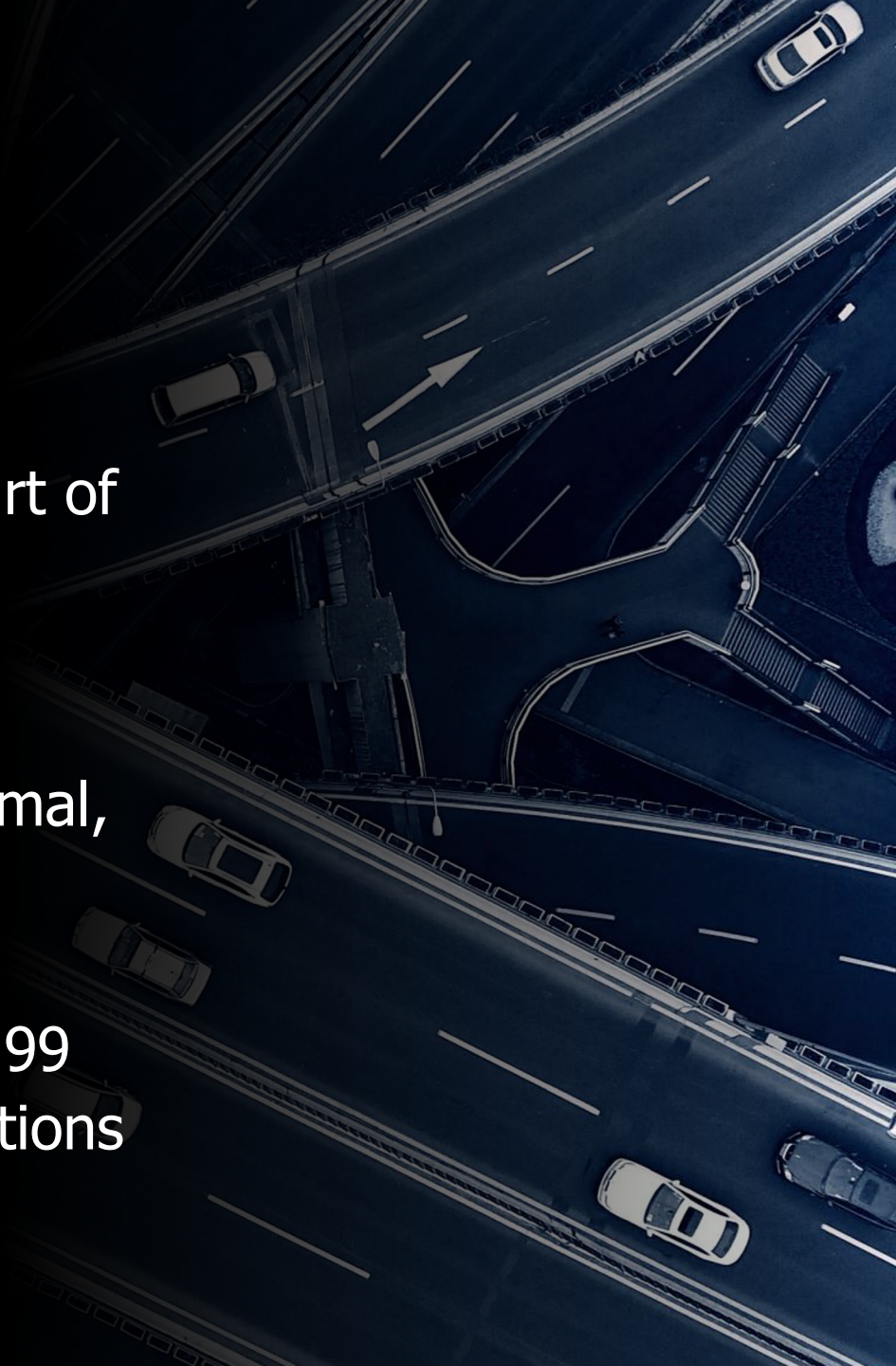
Overview

- Motivation
  - Analysis of driver behavior is an important part of the function and safety of semi-autonomous vehicles
- Objectives
  - Classify driving behaviors as normal or abnormal, and warn drivers about abnormal behaviors
- Results
  - Random Forest model achieves F2-score > 0.99
  - Interactive widget to explore model classifications



Data & Methods

- UAH-DriveSet

- Data collected from smartphone inertial sensors (accelerometer and gyroscope) and GPS
- Drivers are **asked** to simulate “normal” or “abnormal” (aggressive or drowsy) driving
  - Participant/response bias

Data & Methods

- UAH-DriveSet
- Weather Underground

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- Scikit-learn classification models
  - KNN, logit, decision tree, Random Forest

- Choose F2-score as relevant evaluation metric

Data & Methods

- UAH-DriveSet
- Weather Underground

- Scikit-learn classification models
  - KNN, logit, decision tree, Random Forest

- IPywidgets
  - Interactive application of model to new driving behaviors

Results

- Model must:
  - Handle non-linear decision boundaries
  - Have high performance, without overfitting
  - Make fast, real-time classifications

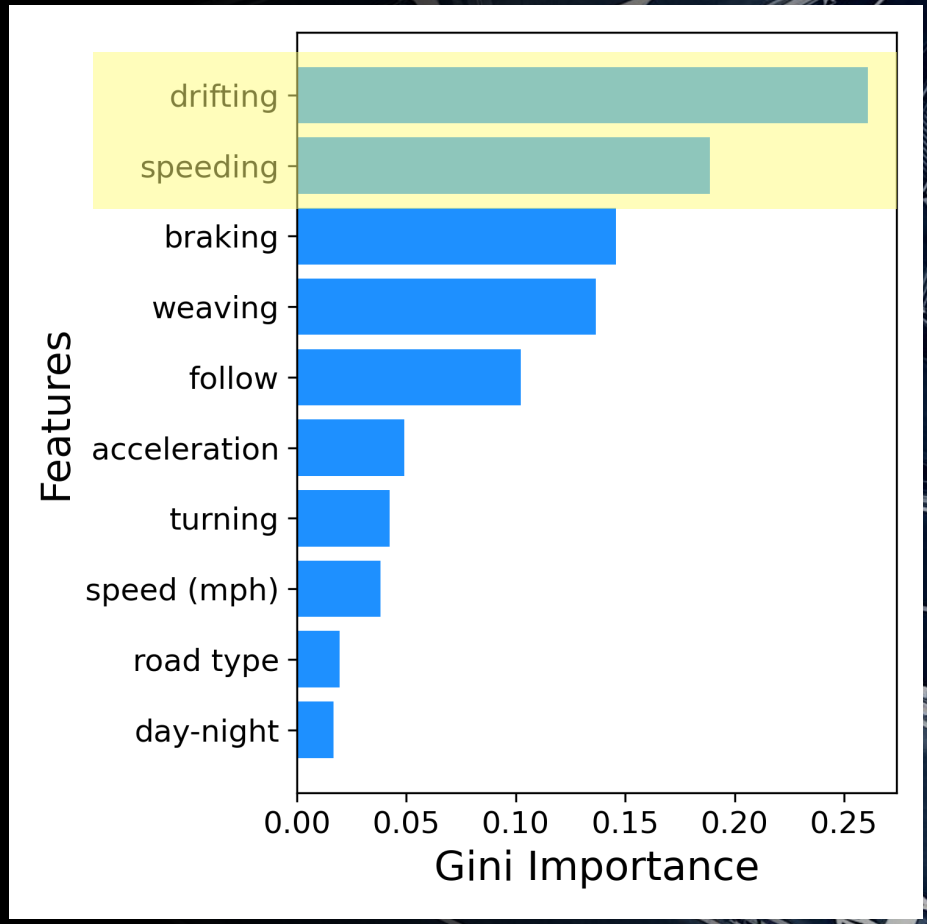
⇒ Select Random Forest classifier (F2 = 0.9925)

Results

- Model has been tuned, but…
- Very high F2-score may (in part) be due to experimental design flaw
  - Participant/response bias
- Asked to drive "normally", driving behaviors are likely safer *because* they are being observed
- Classes are easily separated by the model

Results

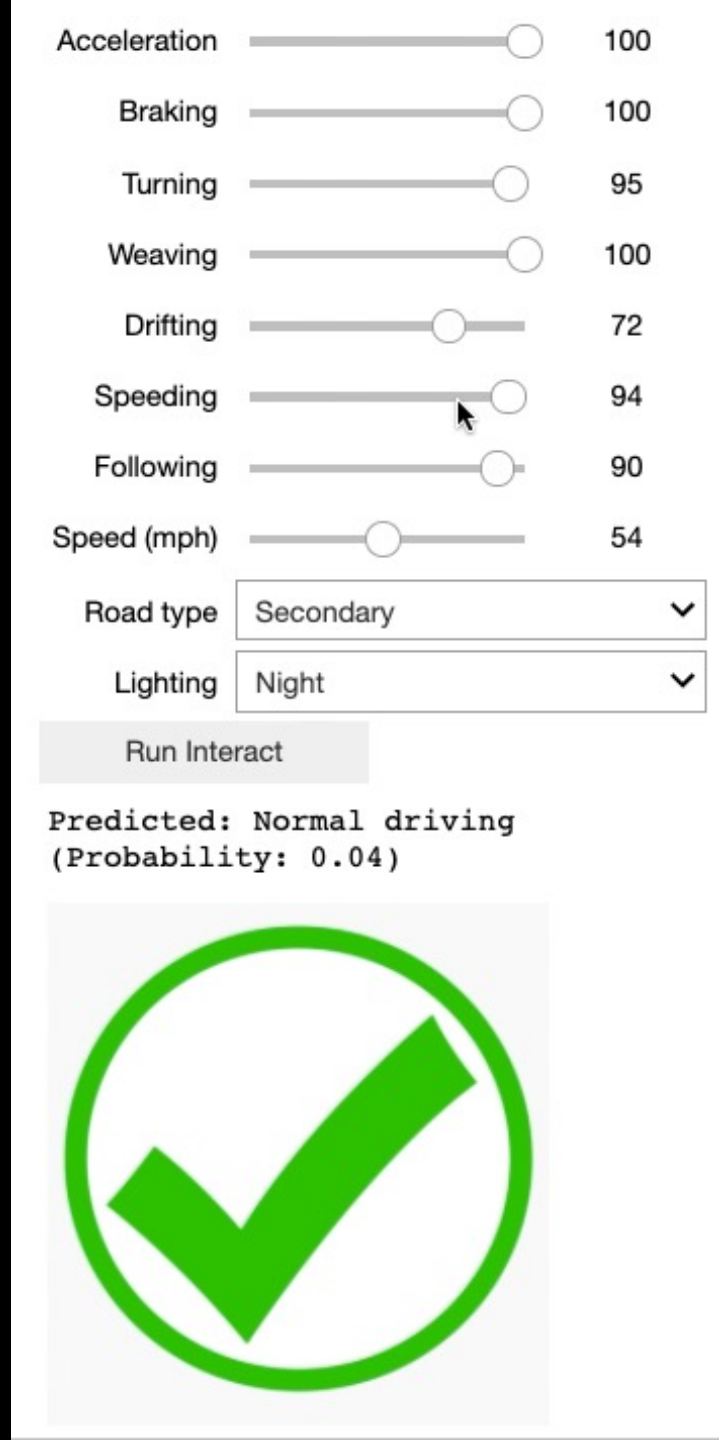
- Drifting (within lane) and speeding are the most important features
- Intuitively, drifting occurs while drowsy-driving and speeding occurs while aggressively-driving



Discussion

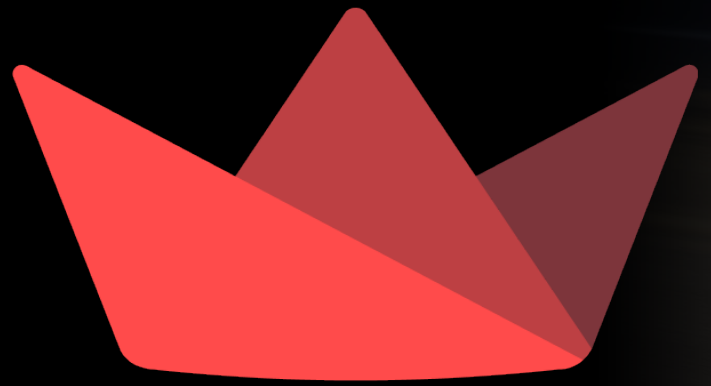
- Interactive widget allows us to explore parameter-space between the two distinct classes in the data set
- "Simulated" driver *starting* to fall asleep at the wheel, determine at what point that system would warn the driver

To interact, go to
tinyurl.com/rfinteract



Future Work

- Data with more real-life observations of driving behaviors (user data from e.g., Waze)
- Tune XGBoost model
- Streamlit App with IPywidget



Questions?

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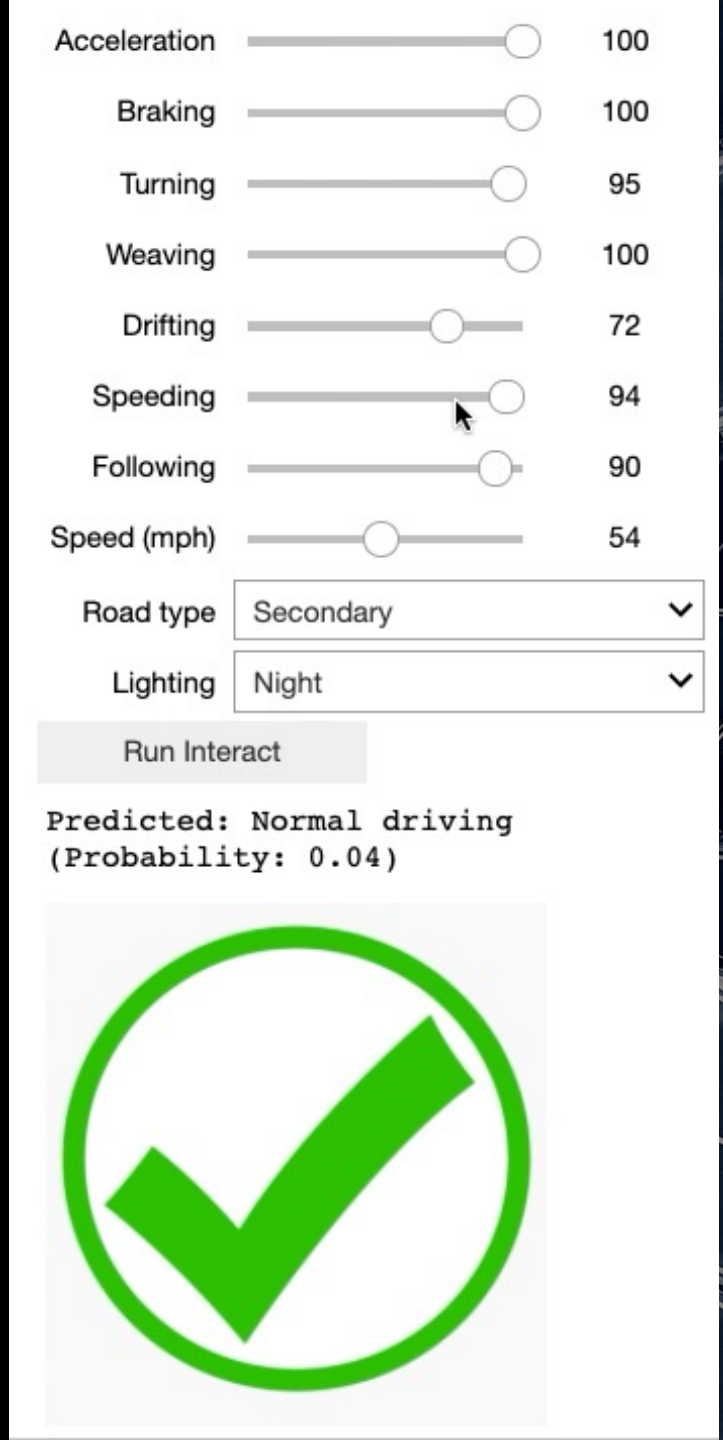
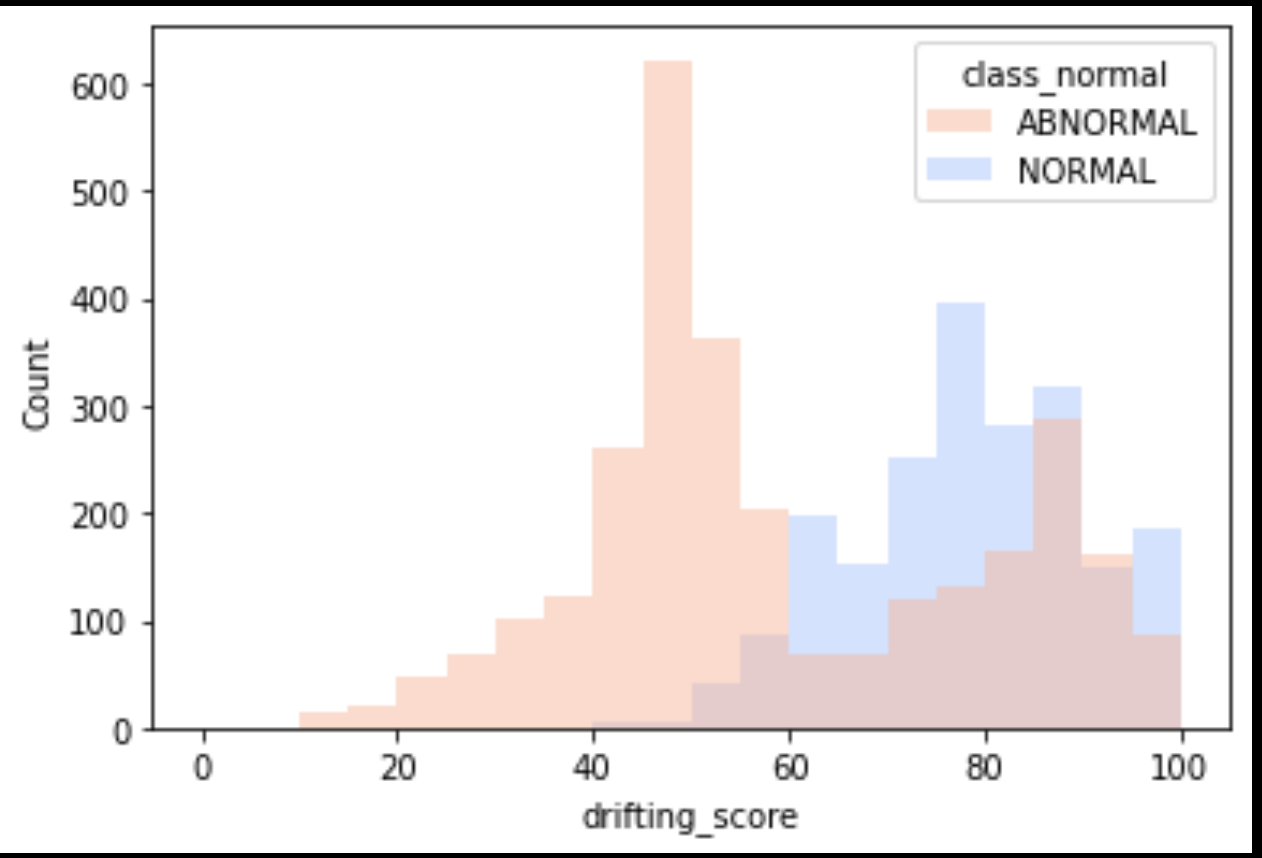
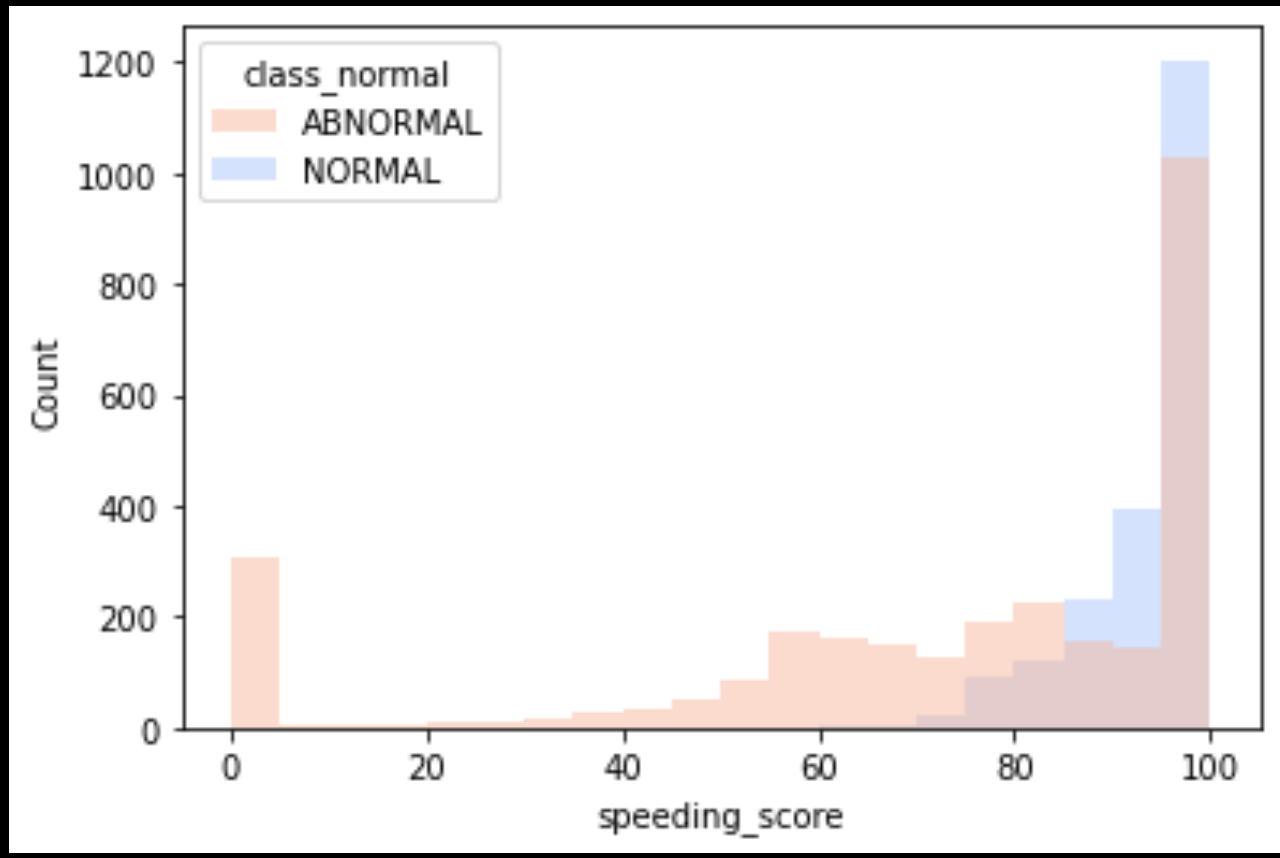
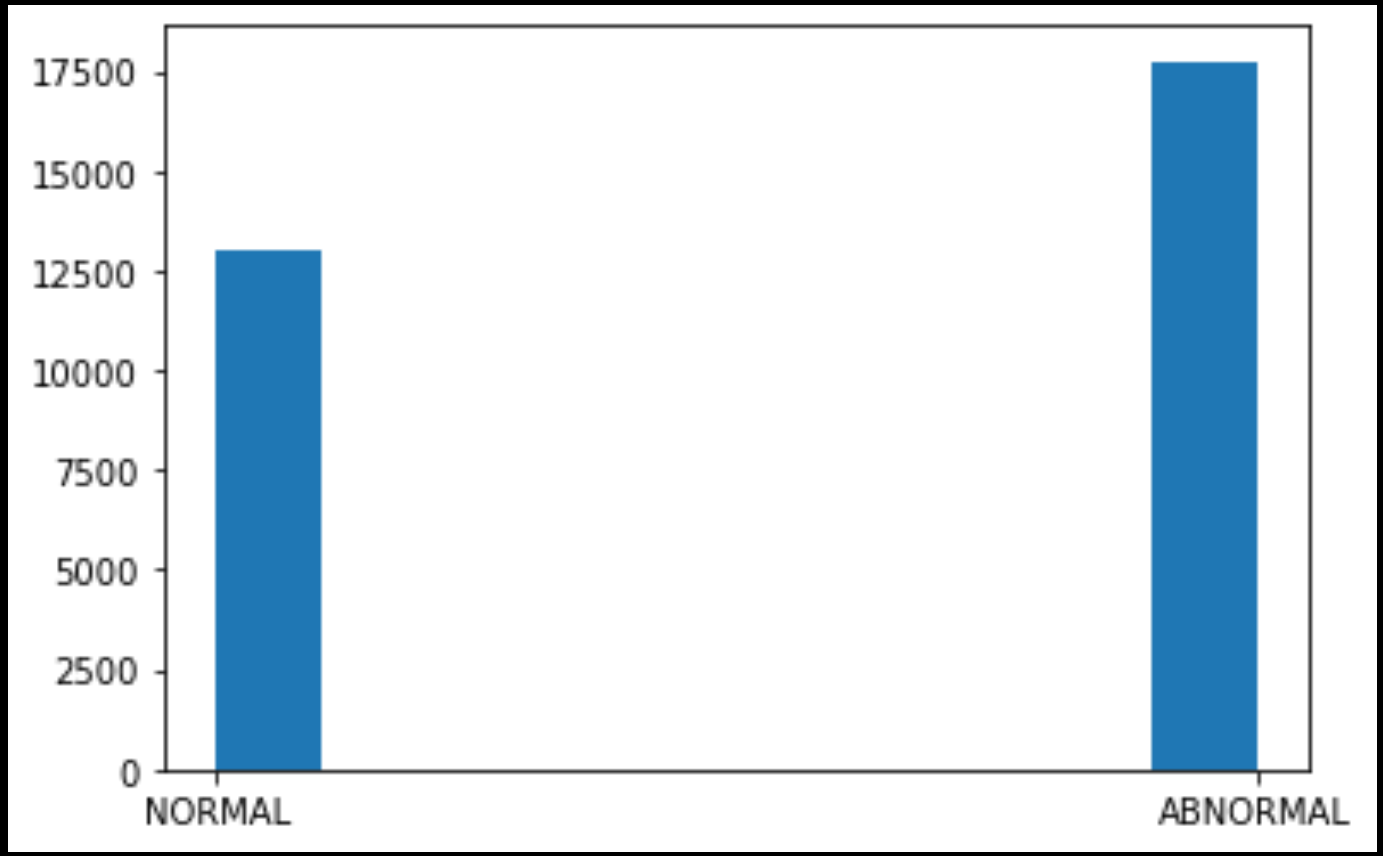
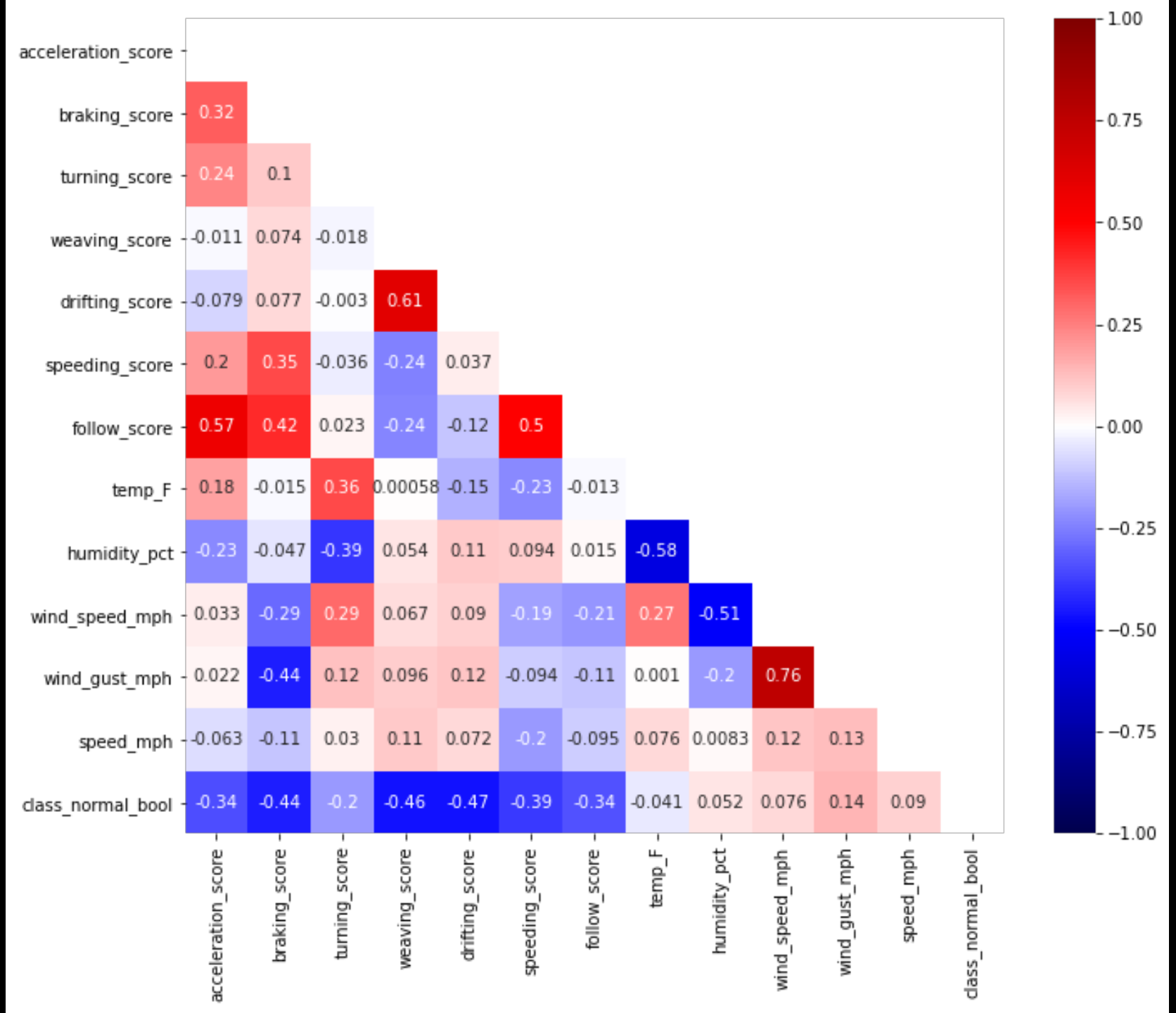


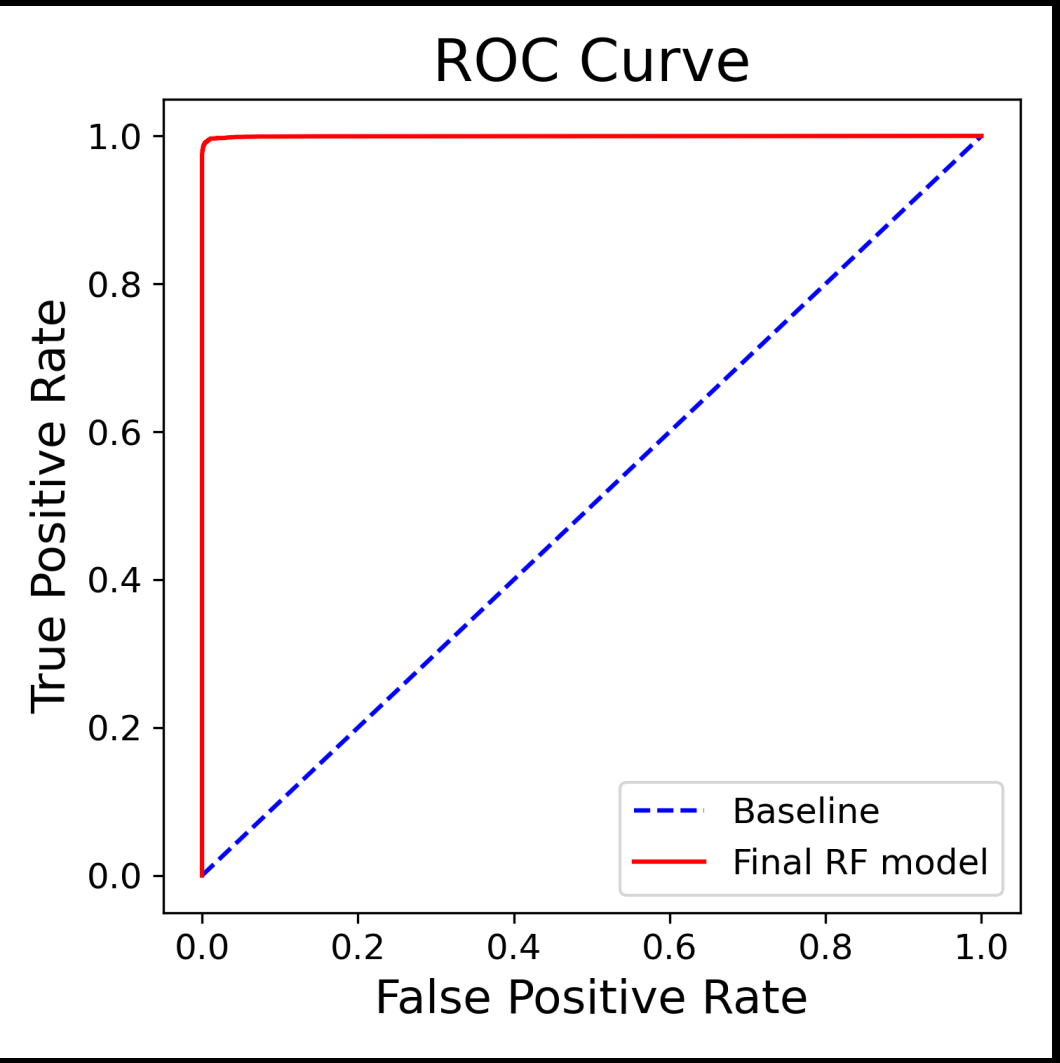
Appendix

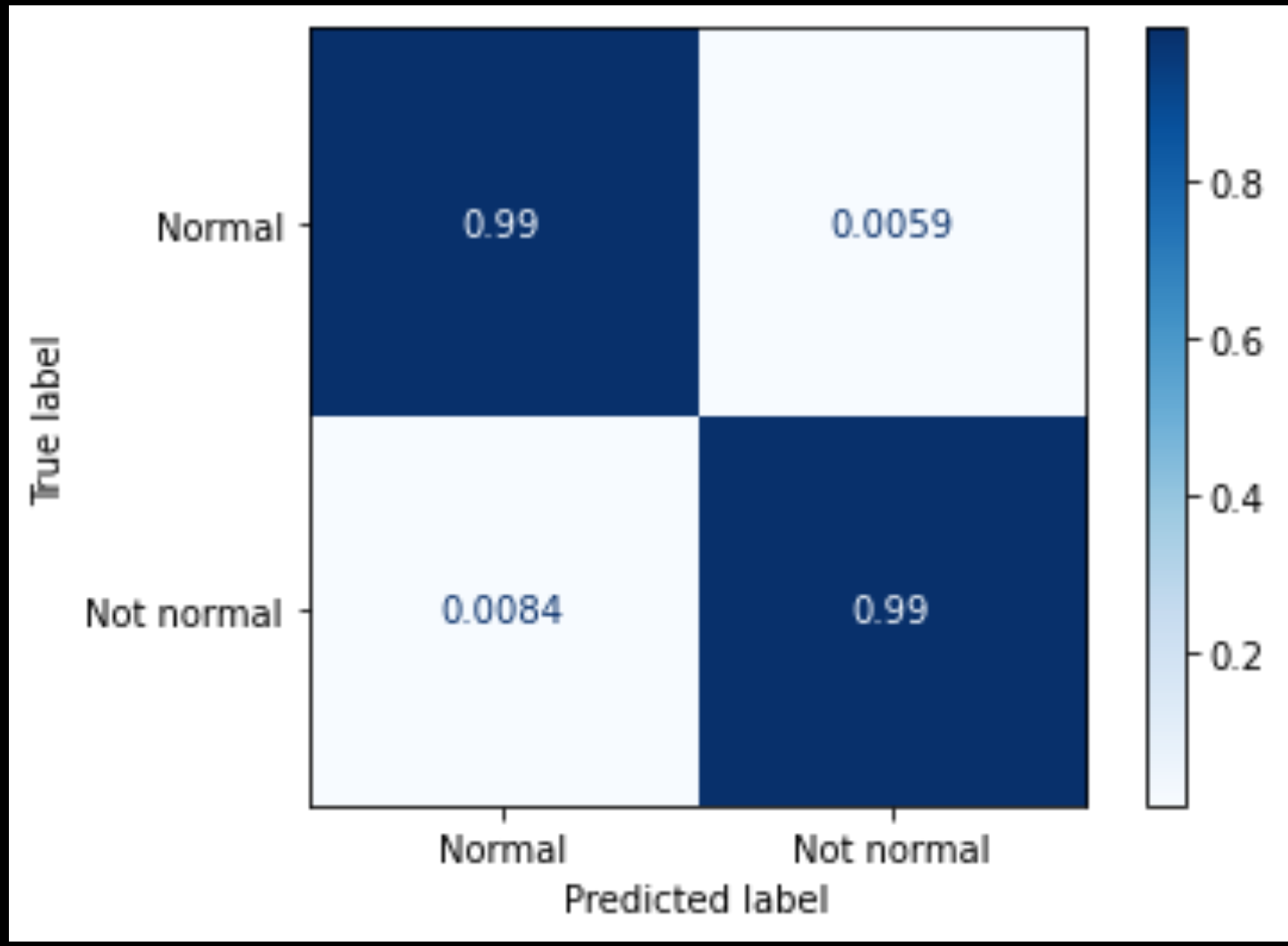

class_normal
ABNORMAL
NORMAL
Count
drifting_score
0
100
200
300
400
500
600
0
20
40
60
80
100

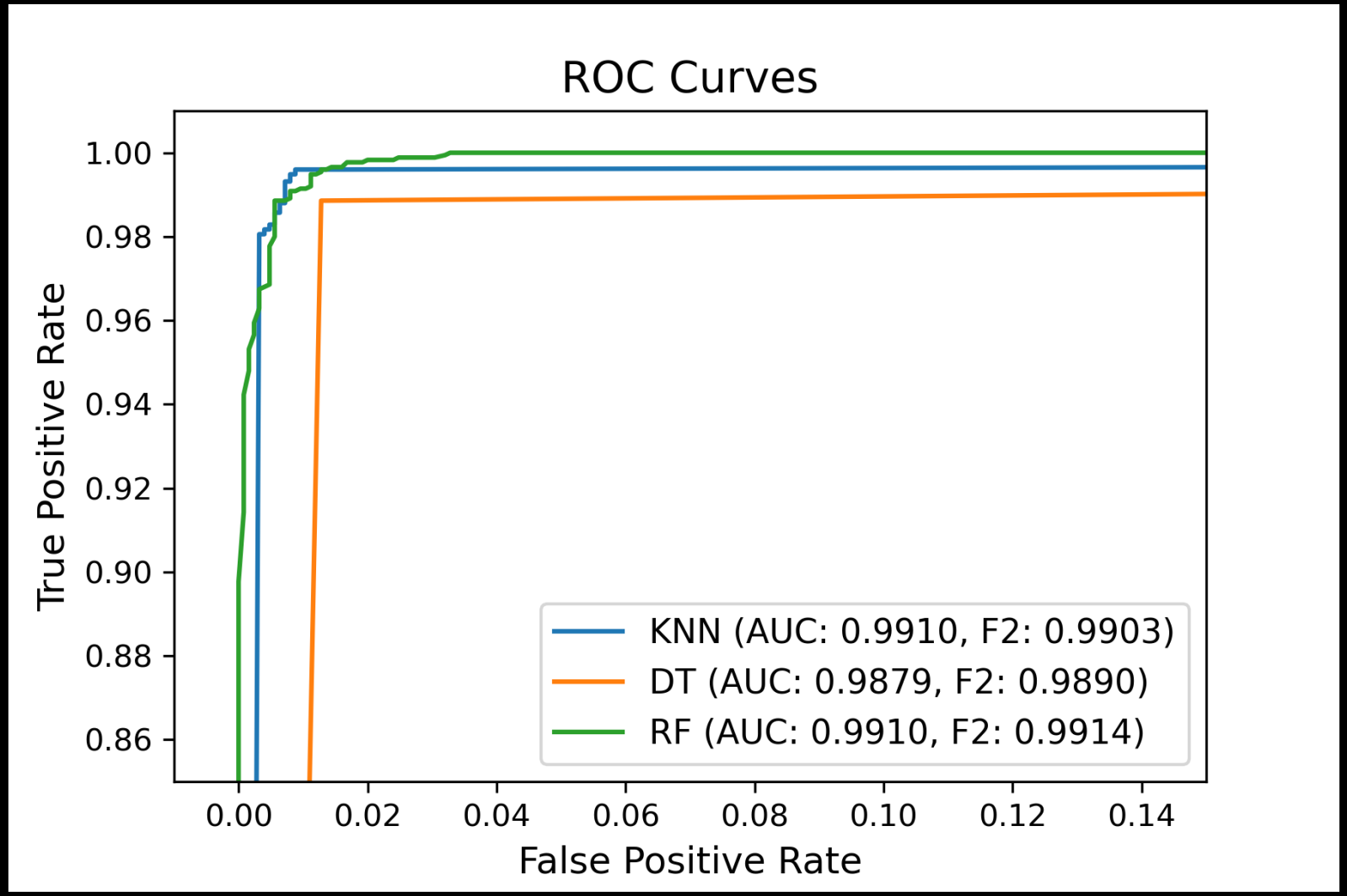

class_normal
ABNORMAL
NORMAL
Count
speeding_score
0
200
400
600
800
1000
1200
0
20
40
60
80
100


17500
15000
12500
10000
7500
5000
2500
0
NORMAL
ABNORMAL


acceleration_score
braking_score
turning_score
weaving_score
drifting_score
speeding_score
follow_score
temp_F
humidity_pct
wind_speed_mph
wind_gust_mph
speed_mph
class_normal_bool
0.32
0.24 0.1
-0.011 0.074 -0.018
-0.079 0.077 -0.003 0.61
0.2 0.35 -0.036 -0.24 0.037
0.57 0.42 0.023 -0.24 -0.12 0.5
0.18 -0.015 0.36 0.00058 -0.15 -0.23 -0.013
-0.23 -0.047 -0.39 0.054 0.11 0.094 0.015 -0.58
0.033 -0.29 0.29 0.067 0.09 -0.19 -0.21 0.27 -0.51
0.022 -0.44 0.12 0.096 0.12 -0.094 -0.11 0.001 -0.2 0.76
-0.063 -0.11 0.03 0.11 0.072 -0.2 -0.095 0.076 0.0083 0.12 0.13
-0.34 -0.44 -0.2 -0.46 -0.47 -0.39 -0.34 -0.041 0.052 0.076 0.14 0.09
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00


ROC Curve
True Positive Rate
False Positive Rate
0.0
0.2
0.4
0.6
0.8
1.0
Baseline
Final RF model


Normal
Not normal
True label
0.99
0.0059
0.0084
0.99
Normal
Not normal
Predicted label
0.8
0.6
0.4
0.2


ROC Curves
True Positive Rate
False Positive Rate
1.00
0.98
0.96
0.94
0.92
0.90
0.88
0.86
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
KNN (AUC: 0.9910, F2: 0.9903)
DT (AUC: 0.9879, F2: 0.9890)
RF (AUC: 0.9910, F2: 0.9914)